

Efficacy of Calcium and Vitamin D Supplementation for the Prevention of Stress Fractures in Female Naval Recruits

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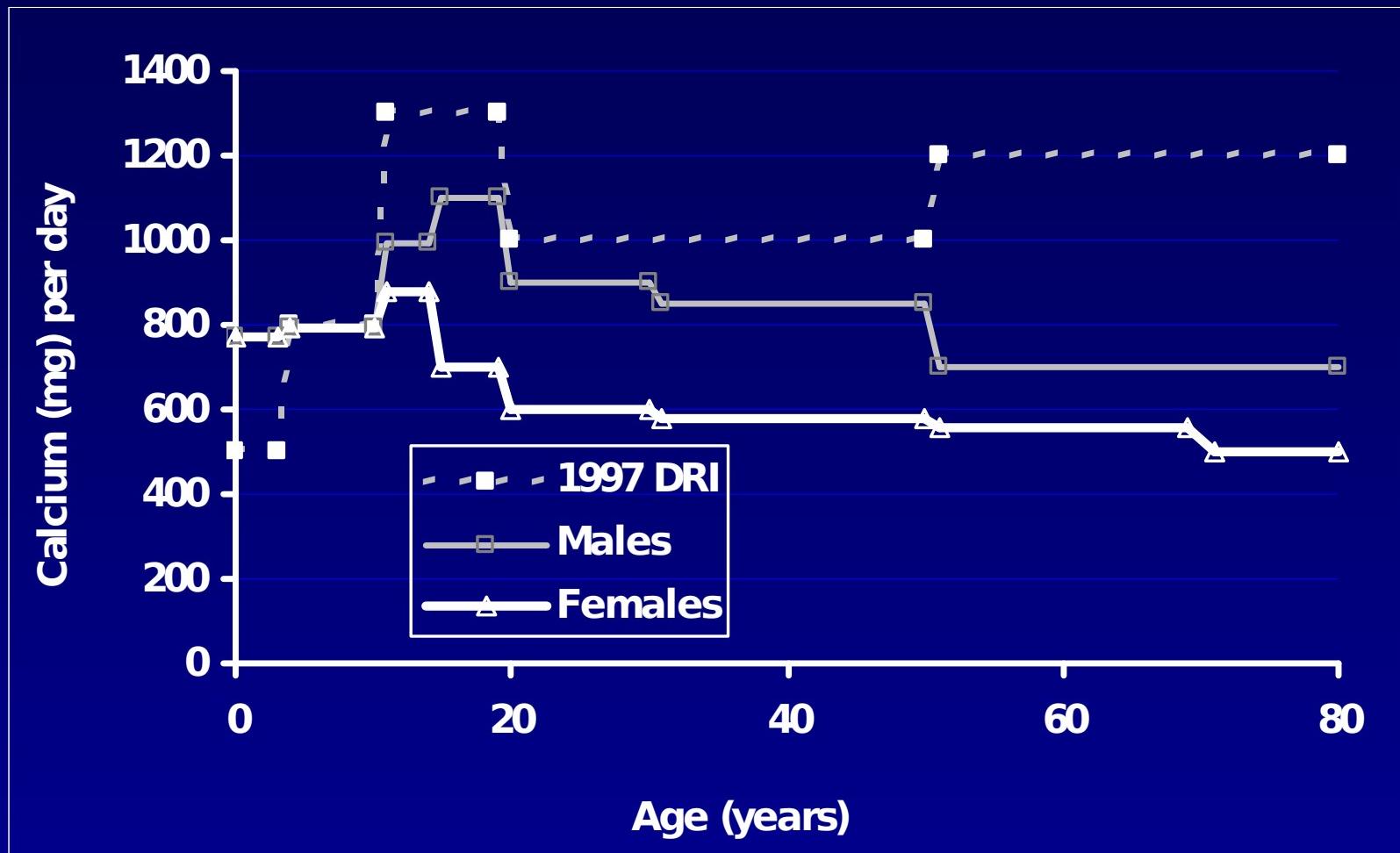
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Low calcium intake is one of the risk factors associated with stress fracture.

Calcium intake across the lifespan



Weaver,
2002

Osteoporosis



Bone Adaptation to Exercise

When physical activity and bone strains are increased above the normally-adapted range, the amount of bone is increased to prevent fracture.

This increase is dependent upon adequate calcium nutrition.

Fatigue Damage in Bone

Like metal -

- bone fatigues when over stressed and develops small cracks
- as the number of cracks increase, structural strength decreases
- ultimately the bone can break with only minor force

Unlike metal -

- bone can heal or repair the damaged tissue
- damaged regions are removed and replaced (remodeling)
- intermittent damage can be repaired to maintain bone



Fatigue Damage Leads to Stress Fracture

Bone Weakens due to

- Accumulation of damage - Injury Rate > Repair Rate

Injury Rate depends on

- initial strength
- relative increase in forces
- rate of new bone formation

Repair Rate depends on

- systemic hormones (PTH, gonadal)
- calcium balance



Calcium Sweat Loss with Exercise

Division 1 A Men's Basketball

Year 1

Ca loss in sweat during 2 hours practice 222
mg

Bone loss in legs over 4 months
6%

Year 2

Supplement with 2000 mg/d Ca

Bone **gain** in legs over 4 months 3%

Kleges et al, JAMA, 1996



Rationale for Calcium Supplementation in Naval Recruits

Calcium Balance is Compromised

1. Ca deficient diet upon entry

Minimum recommended Ca 1000 mg/d

Average Ca intake 19-30 yr old females 600
mg/d

2. High Ca losses occur in sweat
during strenuous activity



Rationale for Calcium Supplementation in Naval Recruits

High Skeletal Calcium Requirements

3. Recruits below age 30 have not achieved peak bone mass and require a positive Ca balance for bone gain.
(maximize peak bone mass)

4. Intense training stimulates bone formation increasing Ca demands. **(maximize bone adaptation)**

5. Microfracture repair is dependent upon Ca availability.
(maximize repair process)



Calcium requirements

- 1000 mg/day for individuals 19-51 yrs of age
(one glass of milk = 300 mg of Ca)
- Ca should be consumed at intervals throughout the day
- Ca supplement pills should be taken with food

Rationale for Vitamin D Supplementation

- Vitamin D (Vit D) assists with Ca absorption and renal retention to improve calcium balance
- Vit D has been shown to maintain or increase bone mass
- Circulating Vit D levels are suboptimal in all age groups
- Sources are not readily available

Milk (women low consumption)

Sun (not available in winter above 37° latitude)

Serum Vit D in submariners decreased in 68 days from 31 - 19 ng/ml



Vitamin D requirements

Recommended minimal intake 400 IU/d

Tolerable limit for supplementation 2000 IU/d

Specific Aims

1. to determine if calcium and vitamin D intervention can reduce stress fracture incidence by at least 50% in female Naval Recruits during basic training.
2. to examine potential mechanisms for increasing bone adaptation to intense mechanical loading.





Over 3 years, we will enroll 5200 female recruits and compare the stress fracture rate between placebo-treated and Ca/vit D-treated women.

Experimental Design

Randomized, Double Blind, Placebo Controlled

Treatment groups

1. **Active** 2000 mg Ca and 800 IU Vit D per day
2. **Placebo** Tablets identical in appearance to Ca/vit D tablets

Subjects will be give two tablets with breakfast and two with dinner



Measurements

1. peripheral quantitative computed tomography (pQCT) of the tibia measured at the beginning and end of basic training. Will assess change in:
 - bone mass, area and density
 - moment of inertia
 - predicted strength
2. Incidence of stress fractures during basic training
3. Questionnaire to determine risk factors for fracture

Procedure

Female Recruits are approached during processing

- written informed consent
- risk factor questionnaire
- random assignment to Ca/Vit D or placebo supplements (red or blue dog tag silencers)
- calendar for recording supplements and menstrual flow
- supplements picked up by recruits in the mess halls at meals
- pQCT (will be obtained in a subset of the subjects)



XCT 3000 (Stratec-Medizintechnik)

Applicability of Findings

The levels of calcium and vitamin D supplementation are very safe.

Cost of supplement pills is low.

Many foods are fortified with calcium.

Thus, positive findings from this study would provide a realistic method of decreasing stress fracture incidence.







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